US DOT, Pipeline and Hazardous Materials Safety Administration, office of Training and Qualifications

SCADA
Supervisory Control and Data Acquisition and
CRM
Control Room Management

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Information Websites

PHMSA Training and Qualification
http://www.phmsa.dot.gov/pipeline/TQ

PHMSA Pipeline Safety Regulations
http://www.phmsa.dot.gov/pipeline/TQ/Regulations

SCADA

- *"SCADA"* does not appear in the Regulations
- **How you use it may include it in regulated functions**
- There are regulatory changes coming

Possible 195 Reference 195.262(a)/(b1)/(b2) Pumping equipment.

(a) Adequate **ventilation** must be provided in pump station buildings to prevent the accumulation of hazardous vapors. **Warning devices must be installed to warn of the presence of hazardous vapors in the pumping station building.** (b) … (1) Safety devices that **prevent over pressuring** of pumping equipment … (2) A device for the **emergency shutdown** of each pumping station….

, Maintenance and normal operations. The manual required by paragraph (a) of this section must include procedures for the following to provide safety during maintenance and normal operations: … (7) **Starting up and shutting down any part of the pipeline system** … consider the hazardous liquid or carbon dioxide in transportation … **pressure monitoring and control devices.**

Possible 195 Reference 195.402(c)(8) Procedures

, Maintenance and normal operations. The manual required by paragraph (a) of this section must include procedures for the following to provide safety during maintenance and normal operations: … (8) In the case of a pipeline that is not equipped to fail safe, **monitoring from an attended location** pipeline pressure during startup until **steady state pressure and flow conditions** are reached and during shut-in

Possible 195 Reference 195.402(c)(9) Procedures

, Maintenance and normal operations. The manual required by paragraph (a) of this section must include procedures for the following to provide safety during maintenance and normal operations: … (9) In the case of facilities not equipped to fail safe … or that control receipt and delivery of the hazardous liquid or carbon dioxide, detecting abnormal operating conditions by **monitoring pressure, temperature, flow or other appropriate operational data and transmitting this data to an attended location.**

Possible 195 Reference
195.404(b)(1) Maps and records.

(b) Each operator shall **maintain for at least 3 years** daily operating records that indicate-- (1) The discharge pressure at each pump station; and ….

Possible 195 Reference 195.408(a)/(b)(1)/(b)(3) Communications.

(a) Each operator must have a communication system to provide for the transmission of information needed for the safe operation of its pipeline system. (b) The communication system required by paragraph (a) of this section must, as a minimum, include means for: (1) Monitoring operational data as required by Sec. 195.402(c)(9); … (3) Conducting two-way vocal communication between a control center and the scene of abnormal operations and emergencies; and ….

Possible 195 Reference 195.406(b) Maximum operating pressure.

...(b) No operator may permit the pressure in a pipeline during surges or other variations from normal operations to exceed 110 percent of the operating pressure limit established under paragraph (a) of this section. Each operator must provide **adequate controls and protective equipment to control the pressure within this limit.**

Possible 195 Reference
195.428 Overpressure safety

Overpressure safety devices and overfill protection systems. (a)… inspect and test each pressure limiting device … or other item of pressure control equipment to determine that it is functioning properly… reliability of operation for the service in which it is used. (c) Aboveground breakout tanks …. must have an overfill protection system ….

(d) After October 2, 2000, the requirements of paragraphs (a) and (b) of this section for inspection and testing of pressure control equipment apply to the inspection and testing of overfill protection systems.

Possible 195 Reference
195.134/444 CPM leak detection.

(134) This section applies to each hazardous liquid pipeline transporting liquid in single phase …. each new computational pipeline monitoring (CPM) leak detection system and each replaced component of an existing CPM system must comply with … API 1130…..(444) Each computational pipeline monitoring (CPM) leak detection system installed on a hazardous liquid pipeline transporting liquid in single phase (without gas in the liquid) must comply with API 1130 in operating, maintaining, testing, record keeping, and dispatcher training of the system.

Prevention Through People (PTP)

Control Room Management (CRM)

PREVENTION THROUGH PEOPLE

- People are a critical element in pipeline safety
- People often play a significant role in preventing, causing, and mitigating the effects of pipeline events
- **PTP** is a strategy through which we hope to provide an integrated and balanced approach to assuring the effectiveness of people
- PHMSA's approach may include consolidating existing and anticipated plans (e.g., OQ, CRM, Damage Prevention)

PTP – Regulatory Parts

PHMSA regulations and initiatives that focus on the role of people in effectively managing safety

- Damage prevention (195.442)

- Public Awareness (195.440)

- Operator Qualification (195 Subpart G)

- Control Room Management

- Drug and Alcohol (199)

PTP – Beyond Regulations

- PHMSA will consider both regulatory and non-regulatory (e.g., best practices) approaches to achieving these objectives

- Strengthening and expanding B31Q is one possible route to such a combined approach, but we are interested in hearing any and all ideas
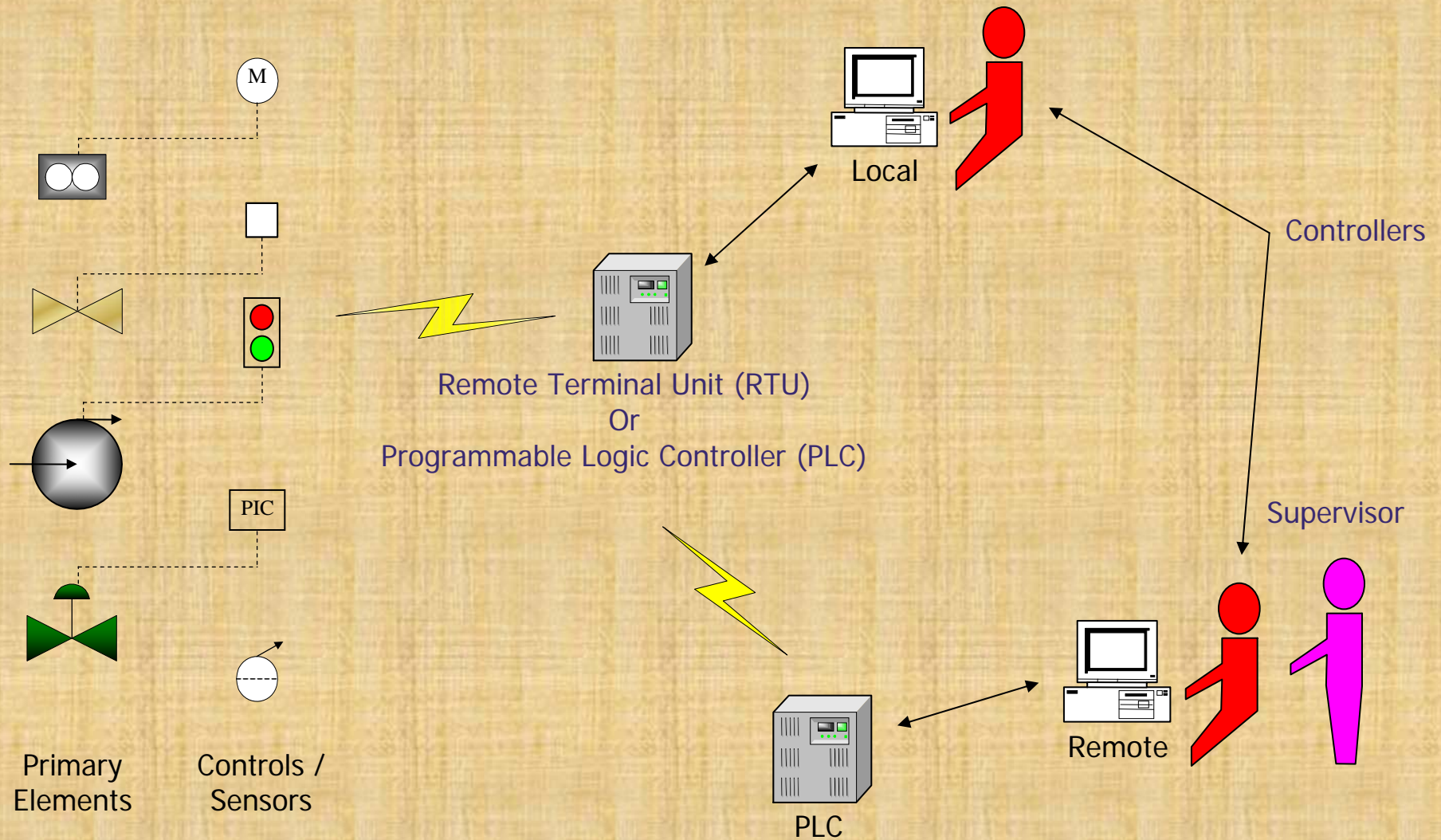
How Does Control Room Management Factor In?

- The PIPES Act of 2006 directs PHMSA to address various risks to pipeline integrity in which people play a large role ... including fatigue and other issues in control room management

- PIPES Act deadline of 6/1/2008 prescribes development of a regulation specifically directed at CRM, but broader concept work is needed for the future
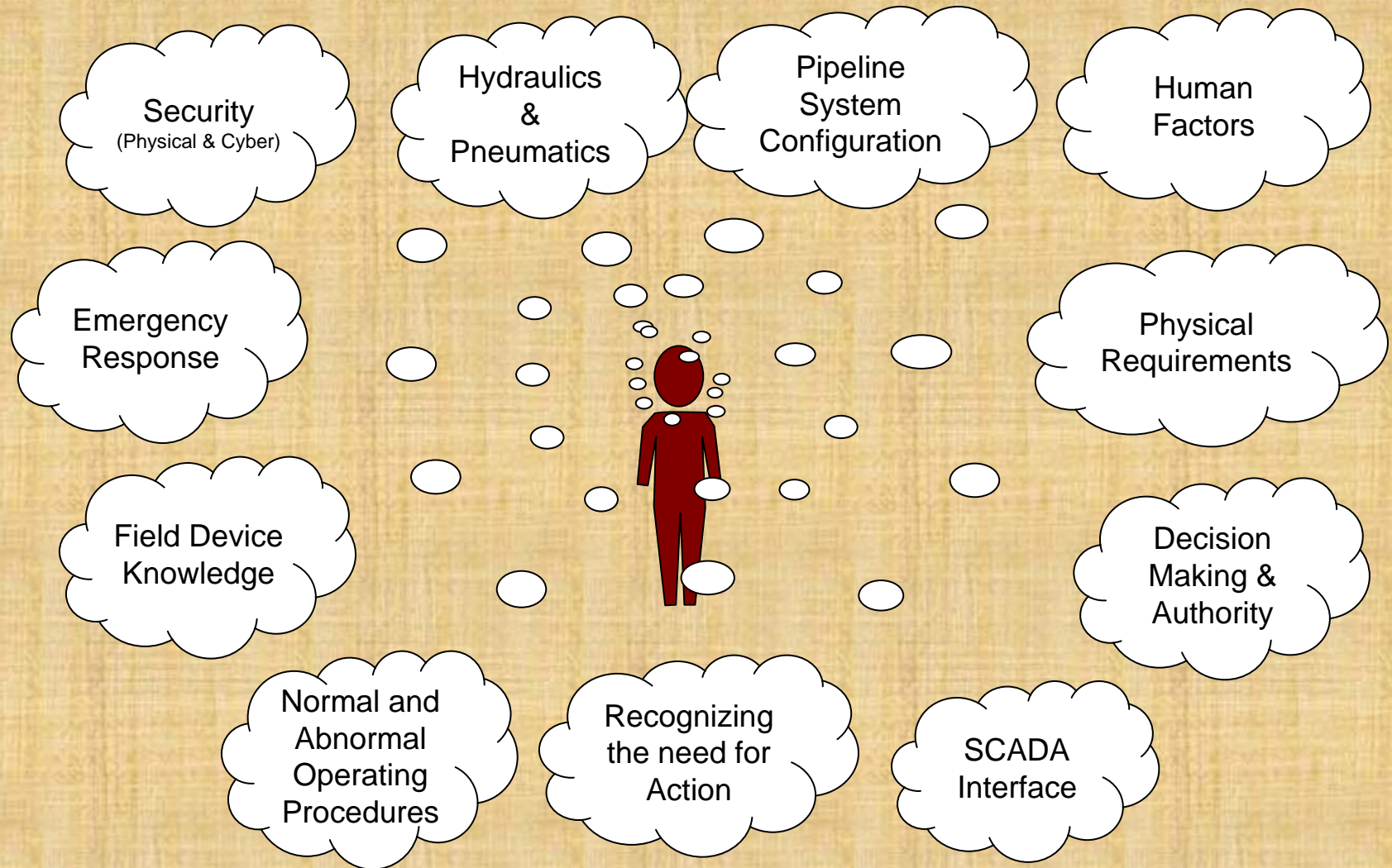
CCERT → CRM

- Controller Certification Project (CCERT) identified measures to enhance the controller's ability to succeed

- Control Room Management (CRM) is developing a rule based on CCERT recommendations and other factors

SCADA and Controllers

M

Local

Controllers

Remote Terminal Unit (RTU)
Or
Programmable Logic Controller (PLC)

PIC

Supervisor

PLC

Remote

Primary
Elements

Controls /
Sensors

Examples of Controller Knowledge, Skills, and Abilities

Security
(Physical & Cyber)

Hydraulics & Pneumatics

Pipeline System Configuration

Human Factors

Emergency Response

Physical Requirements

Field Device Knowledge

Decision Making & Authority

Normal and Abnormal Operating Procedures

Recognizing the need for Action

SCADA Interface

Project Drivers

- Pipeline Safety Improvement Act of 2002
  - Study control room operations to enhance pipeline safety
  - Provide report to Congress
- NTSB
  - SCADA Safety Study, based on Liquid Pipeline Systems
- PIPES Act of 2006 (Sections 12, 19, 20)
  - Establish human factors management plan
  - Reduce risks associated with human factors
  - Program to assure safe operation of pipelines
  - NTSB Recommendations on Displays, Alarms and Training
  - Accident/incident form changes on Fatigue by Dec. 31, 2007
  - **Issue regulations by June 1, 2008**
- PHMSA Objective
  - Identify CRM enhancement areas to help assure and promote the Controller's ability to succeed in maintaining pipeline safety and integrity

Field Survey Topics

- Operator System Overview, Control Room Tour
- Process Steps for Controller Development and Qualification
- Controller Operating Logistics and Experience Base
- OQ Implementation Resources
- Task Identification
- Candidate Selection
- Initial Training
- Computer Modeling and Operations Support Systems
- Qualification
- Ongoing Controller Performance Monitoring
- Re-Qualification
- Qualification Revocation and Restoration

- Root Cause Analysis and Feedback
- Global Metrics
- SCADA Controller Operations Interface
- SCADA System Design/Configuration
- Alarm Configuration, Management and Operations
- Security and Access Control
- Controller Interview
- Control Management Interview
- Management of Change
- Ancillary Procedures, Systems and Work Environment
- Administrative Support and Records Management
- Upcoming Systems and Procedure Changes

Observations Summary-1

- Pipeline incidents/accidents are usually caused by mechanical damage, material defects, or corrosion

- Controllers frequently have a key role in emergency response

- A Controller's job frequently places them in a critical position to aid in the prevention, identification or mitigation of abnormal situations

- The established OQ framework is well-suited for administering OQ for Controllers

- Controllers know how to complete actions but on rare occasions they do not:
  - Detect and react as expected
  - Choose the right action

- From a risk perspective, low probability of controller error can be offset by the potential consequences of their actions/errors

Observations Summary-2

- Gas and Liquid controllers require similar cognitive and analytical skills
- The speed of response is especially critical for liquid pipeline controllers
- A Controller can be qualified but not always successful in managing abnormal situations due to many other factors (such as thoroughness of procedures, SCADA system design, fatigue, etc.)
- Many pipeline operators use SCADA systems to enhance safety and efficiency

NTSB SCADA Safety Study on Liquid Pipelines Recommendations

- API RP-1165, Display Graphics
- Review/Audit of SCADA Alarms
- Simulator and Table-Top AOC Training
- Report Fatigue Data for Accidents
- Computer-based Leak Detection Systems for Hazardous Liquid Pipelines

CRM (NPRM) will address the first three recommendations
CRM and other development work will address report data
PHMSA will address Computer-based Leak Detection Systems separately

Executive Summary Highlights
As a part of the OQ Report to Congress in Dec-2006

- ▣ The cognitive and analytical skills required of a controllers are universal

- ▣ Hazardous liquid operators generally need their controllers to detect and react to upset conditions more quickly than natural gas operators

- ▣ Control room working environments should include fatigue mitigation strategies

Executive Summary Highlights As a part of the OQ Report to Congress in Dec-2006

(Continued)

- A uniform certification test for controllers would provide only limited value due to the diversity in control room equipment and the differences in tasks the controllers perform

- Validating the adequacy of CRM processes, procedures, training and the controllers' qualifications would improve management of control rooms and enhance safety

- Several specific areas have been identified to enhance the safety performance of control rooms

Enhancement Areas

- **Roles and Responsibilities**

- **Controller Qualifications**

- **Fatigue Mitigation**

- **Shift Change**

- **SCADA Displays**

- **Alarm Management**

- **Operating Experience**

- **Change Management**

- **Validation**

Enhancement Areas
Roles and Responsibilities

- Many pipeline operators have established job descriptions for controllers, but these frequently do not include clear language about the controller's authority and responsibility for safety-related decision making and action

- Controllers frequently have a key role in emergency response even if they were not the first to detect a problem

Enhancement Areas
Roles and Responsibilities

(continued)

▫ Some operators have not provided Controllers with the fundamental information being provided to the public as the result of the PSIA 2002 Public Education Program requirements and RP-1162.

▫ When Controllers answer "800" calls from stakeholders, some operators have not trained Controllers about "how to respond" in the event of an emergency and to coordinate with other operators in common corridors.

Enhancement Areas
Controller Qualifications

- Most operators do not measure or verify a controllers performance in regards to detecting abnormal and upset conditions and their ability to take appropriate action as needed

- Many pipeline operators do not apply controller performance verification between formal re-qualification intervals.

- Many operators do not verify hearing, colorblindness (color perception) or vision abilities as required in order to operate their system.

Enhancement Areas
Controller Qualifications

(continued)

- Many pipeline operators do not place enough training and qualification emphasis on abnormal conditions that are likely to occur simultaneously or in sequence, as indicators or precursors of more serious situations

- Many operators' training programs do not include a review of procedures for pipeline operating setups that are periodically, but infrequently used.

Enhancement Areas
Fatigue Mitigation

- The control room shift schedule of many pipeline operators was chosen for the convenience of controllers. Few pipeline operators have studied the effect of shift schedule on work diligence, safety performance, circadian rhythms, or fatigue.

- Many operators do not review shift rotation schedules, shift length, and hours of service for their impact on Controller fatigue

Enhancement Areas
Shift Change

- Many operators expect Controllers to overlap their shifts, but there are usually no formalized procedures requiring overlap

- Many pipeline operating companies do not have formalized shift-change procedures or associated check-off sheets.

Enhancement Areas
SCADA Displays

- Few pipeline operators perform routine point to point checks verifying modifications in the field have not affected controller screens.

- Many operators do not have a structured plan for determining which and how many colors should be used on their SCADA displays

- The American Petroleum Institute has published Recommended Practice 1165 for the use of graphics on the SCADA screens.

Enhancement Areas
Alarm Management

- Many operators are not performing alarm reviews that include consideration of:
    - number of alarms
    - unnecessary alarms
    - controller's performance changing regarding alarm or event response
    - alarm indication of AOC

Enhancement Areas
Alarm Management

- Many pipeline operators do not perform a periodic structured alarm analysis to identify chronic or systemic equipment problems, the need for procedure revisions, or to help monitor controller performance.

Enhancement Areas
Operating Experience

- Operators consider table-top "what-if" exercises as valuable training aids
- Computer-based simulators were frequently characterized by Controllers as a valuable tool, but seen as cost prohibitive by many operators

Enhancement Areas
Operating Experience

(continued)

- ▣ Simulators and table-tops can be valuable tools for the recognition of abnormal operating conditions, in particular leak events.

- ▣ Controllers were seldom asked about how table-top exercises could be improved or were involved in table-top exercise scenario development.

- ▣ Some operators collect and analyze near miss and close call events and take corrective actions including training activities

Enhancement Areas
Change Management

- Many operators do not have maintenance procedures in place to deal with problems identified by the controller that may exist in the SCADA system or field instrumentation.

- Procedures need to be in place so the Controllers can prioritize outstanding work that needs to be completed on the SCADA system.

- Many operators do not have procedures or processes to ensure SCADA system modifications are coordinated with Controllers and pipeline operating logistics.

Enhancement Areas
Change Management

(continued)

- ▣ Controller field visits were commonly seen as valuable with respect to acquainting the Controller with the physical aspects of the controlled equipment and facilities

- ▣ Controllers indicated it was especially significant for field visits to be conducted with the associated field personnel that the Controller would be communicating with during the normal course of duties and emergency situations.

- ▣ Controllers are not always represented when pipeline hydraulic or configuration changes are being considered.

Enhancement Areas
Validation

These observations lead to a conclusion that validation through executive signature would be appropriate for:

- Review of controller qualifications and training program,

- Verification that only qualified controllers have operated the pipeline,

- Verification that enhancement areas have been implemented as required,

- Verification that ergonomic and fatigue factors continue to be addressed,

- Verification that controllers have a voice in finding ways to sustain and improve control room management

PHMSA is also considering the following actions

- Participating and planning events to enhance communication with other modes of transportation regarding control room lessons learned

- Sponsoring workshops for pipeline operators to share control room management best practices

- Encouraging the development of consensus-based best practices to promote controller success

- Initiating a research and development project to establish a web-based generic simulation tool to help train controllers of smaller pipeline operators

CRM Risk Considerations

▫ Control rooms rank very low as a cause of failures compared to mechanical damage, material defects and corrosion; but controllers are frequently involved in identifying and/or responding to most situations, including the mentioned types of failures

▫ Low probability of controller error can be offset by the potential consequences of their actions/errors

▫ Remote monitor/control may be performed in a formal control room, or numerous less formal settings such as individual office, service vehicle or residence. Location of monitor or control does not define the nature, complexity or risks to pipeline safety

CRM Risk Considerations

(continued)

- Many Controllers monitor only, consulting or deferring to field personnel for actions to be taken. In these cases, actions of field personnel can mitigate or contribute to CRM risks.

- Established definitions such as large and small operators, and "less than 20% SMYS", are not good qualifiers in defining control room risks

- More complex and diverse operations call for more thorough control room systems and processes

CRM Rule-Making Considerations

- NPRM Development, in progress
- Performance & Risk based approach (similar to IMP)
- NPRM to account for both gas and liquid
- Operators to address all applicable CRM risk factors
- Compliance criteria and implementation timeline, TBD
- Most operators account for many of the enhancement areas, some without a documented basis for their design choices, and some without formalized procedures

THE END!